# CHAPTER 3
# AIRWORTHINESS STANDARDS
# NORMAL CATEGORY ROTORCRAFT

## MISCELLANEOUS GUIDANCE (MG)

AC 27 MG 12. § 27.865 (Amendment 27-36) EXTERNAL LOADS.

a. Background. In the United States (U.S.), the external load attaching means standards for transport and normal category rotorcraft were originally contained in Subpart D, "Airworthiness Requirements of FAR Part 133, Rotorcraft External-Load Operations." Amendment 29-12, issued in 1977, added a new § 29.865, which moved these standards from Part 133 to Part 29. An identical transfer occurred in 1977 for Part 27. Amendment 29-26, issued in 1990, clarified the intent of Amendment 29-12 but did not change it substantively. Transport Categories A and B and Normal Category rotorcraft were initially used under Part 133 operations, and after Amendment 133-6, restricted category rotorcraft were also included under Part 133 operations. The carriage of persons external to the rotorcraft for hire first came about when a Part 29 operator, exempt from Part 133, transferred harbor pilots to and from ships by a hoist and sling. The exemption was granted to study the feasibility of passenger transfer outside of the cabin. Grant of the exemption was based, in part, on similar, prior operations that had been conducted in Europe and Africa, for hire, with helicopters certified by the appropriate authorities and, in part, on similar military and public helicopter operations, not for hire, in the U.S. Subsequently, Amendment 133-9, adopted in January 1987, established a new Class D rotorcraft load combination (RLC) for transporting loads other than Class A, B, or C that are specifically approved by the administrator external to the rotorcraft. Amendment 133-9 also provided for the limitations and conditions for transport of external loads other than Class A, B, or C and the necessary, associated safety requirements. Part 27 is not eligible for RLC Class D, because of the current restriction of § 133.45(e) that limits use of RLC Class D to Part 29 Category A rotorcraft (under the performance limits prescribed in § 133.45(e).) Part 29 has recently been changed to reflect RLC Class D requirements. Also, the scope and thus the title of the standard have changed from "External load attaching means" to "External loads" to reflect the more comprehensive approach for external loads required to ensure the proper level-of-safety.

(1) In other Nations the operations standards have developed differently and more diversely and do not necessarily use the RLC Class A, B, C and D definitions of § 1.1 in the same way as FAA operations standards do. Thus the International commonality of this advisory material (like § 27.865) is based on whether or not an external load is jettisonable or non-jettisonable and whether or not the load is HEC or NHEC.

(2) Whenever possible, the more generic, internationally harmonized terminology (i.e., jettisonable or non-jettisonable and HEC or NHEC) is used in this material. However, references to U.S. operational terms are made in parentheses

where deemed necessary and tabulated to ensure clarity of purpose and proper, consistent approvals to U.S. operations standards.

b. Explanation.

(1) This advisory material contains guidance for certification of helicopter external load attaching means and load carrying systems to be used in conjunction with operating rules such as Part 133, "Rotorcraft External Load Operations." Subpart D of Part 133 contains supplemental U.S. airworthiness requirements. FAR Part 1 defines four RLC classes that (with the exception of RLC Class D due to the restriction of 133.45(e))are approvable under the U.S. Part 133 operating rules and that are eligible for certification under § 27.865. The three U.S. RLC classes (and their eligibility for Part 27 use based on U.S. operational requirements) are summarized in FIGURE AC 27.MG 12-1 and discussed in paragraph d. Under U.S. operating rules RLC Classes A, B, and C are eligible, under specific restrictions, for both human external cargo (HEC) and nonhuman external cargo (NHEC) operations. However, under U.S. operating rules, RLC Class D only is eligible for transporting HEC for compensation (see FIGURE AC 27.MG 12-1). For further information, AC 133-1A, "Rotorcraft External-Load Operations in Accordance with FAR Part 133," October 16, 1979, may be reviewed. Also, paragraph AC 27.25 (reference § 27.25) concerns, in part, jettisonable external cargo.

(2) FAR 27.865 provides a minimum level of safety for rotorcraft designs to be used with operating rules such as Part 133. Certain aspects of operations such as microwave tower and high-line wire work may also be regulated separately by other Federal agencies such as DOE, EPA, and OSHA or by other international entities. For applications that could come under multiple agency regulation (or regulation by other entities), special certification emphasis will be required by both the applicant and the certifying authority to ensure all relevant safety requirements are identified and met. Potential additional requirements, where thought to exist, are noted herein.

(3) The methods of this AC are intended to apply only to either new designs or to major modifications that occur after the effective date of Amendment 27-36 (i.e., "ADD DATE"). Thus it is not intended that these requirements be imposed retroactively. However, after the effective date of Amendment 27-36 all applications to certify new rotorcraft systems for NHEC or HEC operations would be required to comply with the equipment standards, as well as, the operational requirements in effect at that time.

c. Definitions.

(1) Applicable cargo type. The cargo type (i.e., NHEC, HEC, or both) that each RLC Class is eligible to use by regulation (FIGURE AC 27.MG 12-1 contains explicit definitions for U.S. Part 133 Operations).

(2) Backup Quick-Release Subsystem (BQRS). The secondary or "second choice" subsystem used to perform a normal or emergency jettison of external cargo.

(3) Cargo. The part of any Rotorcraft-Load Combination that is removable, changeable, and is attached to the rotorcraft by an approved means.

(4) Cargo hook. A hook that can be rated for both HEC and NHEC. It is typically used by being fixed directly to a designated hardpoint on the rotorcraft.

(5) Critical configuration. In cases where NHEC or HEC can have more than one shape, center-of-gravity, center-of-lift, and/or be carried at more than one distance in flight from the rotorcraft attachment, a critical configuration for certification purposes may or may not be determinable. If such a critical configuration can be shown to exist, then it may be examined for approval as a "worst case" (in lieu of examining the entire range of configurations that exist) to satisfy a particular certification criterion or several criteria, as appropriate.

(6) Dual actuation device (DAD). This is a sequential control that requires two distinct actions in series for actuation. One example is a covered switch that would require cover removal (or flip-up) followed by a switch activation for load release to occur. Another example is removal of a lock pin followed by a "then free" switch or lever activation for load release to occur. Under this definition, a load release switch protected by an uncovered switch guard is not acceptable.

(7) Emergency jettison (or complete load release). The intentional, instantaneous release of NHEC or HEC in a preset sequence by the QRS that is normally performed to achieve safer operation in an emergency (i.e., nonoptimum situation).

(8) External fixture. A structure external to and in addition to the basic airframe that does not have true jettison capability and has no significant payload capability in addition to its own weight. An example is an agricultural spray boom. These configurations are not "External Loads" certifiable under § 27.865.

(9) Fixed line flyaway. This is a helicopter extrication technique in which a person or persons in a PCDS are connected to a rope or cable attached to a helicopter. The aircraft lifts off with the HEC carried below it. The exact length of the line depends on the specific needs of the operation.

(10) Human external cargo (HEC). A person(s) that at some point in the operation is carried external to the rotorcraft. (FIGURE AC 27.MG 12-1 contains explicit definitions for U.S. Part 133 Operations).

(11) Nonhuman external cargo (NHEC). Any external cargo operation that does not at any time involve a person(s) carried external to the rotorcraft (FIGURE AC 27.MG 12-1 contains explicit definitions for U.S. Part 133 Operations).

(12) Normal jettison (or selective load release). The intentional release, normally at optimum jettison conditions, of an NHEC.

(13) Personnel carrying device system (PCDS). The entire attached or suspended system used to carry HEC. This is any HEC carrying configuration such as a suspended (e.g., winch/hoist, cable, harness) HEC system or an attached (e.g., a rigid basket or cage attached to skids) HEC system.

(14) Primary Quick-Release Subsystem (PQRS). The primary or "first choice" subsystem used to perform a normal or emergency jettison of external cargo.

(15) Quick-release system (QRS). The entire release system for jettisonable external cargo, (i.e., the sum total of both the primary and backup quick-release subsystems). The QRS consists of all components including the controls, the release devices, and everything in between.

(16) Rescue hook (or hook). A hook that can be rated for both HEC and NHEC. It is typically used in conjunction with a winch/hoist or equivalent system.

(17) Spider: A spider is a system of attaching a lowering cable or rope or a harness to an HEC (or NHEC) RLC to eliminate unwanted flight dynamics during operations. A spider usually has four or more legs (or load paths) that connect to various points of a PCDS to equalize loading and prevent spinning, twisting, or other undesirable flight dynamics.

(18) True jettison capability. The ability to safely release an external load using an approved QRS in 30 seconds or less.

NOTE: In all cases, a PQRS should release the external load in less than 5 seconds. Many PQRS's will release the external load in milliseconds, once the activation device is triggered. However a manual BQRS such as a set of cable cutters could take as much as 30 seconds to release the external load. The 30 seconds would be measured starting from the time the release command is given and ending when the external load is cut loose.

(19) True payload capability. The ability of an external device or tank to carry a significant payload in addition to its own weight. If little or no payload can be carried, the external device or tank is an external fixture (see definition).

(20) Type inspection authorization (TIA). This is FAA Form 8110-1. It is used only for the purpose of authorizing official ground inspections and flight tests necessary to fulfill the requirements for type certification or supplemental type certification. Order 8110.4, Chapter 2, Section 1, Paragraph 16, states the criteria for TIA issuance.

(21) Winch/hoist. A winch is defined as a device that can employ a cable and drum or other means to exert a horizontal (i.e., x-rotorcraft axis) pull. A hoist is a similar device that exerts a vertical pull (i.e., a pull that does not typically exceed a 30 degree cone measured around the z-rotorcraft axis). The majority of "pull" devices used on rotorcraft are hoists. However, since a winch can be used to perform a hoist function by use of a 90 degree cable direction change device (such as a pulley or pulley system), a winch system is approvable. Thus the terms "winch/hoist" and "winch/hoist system" are used throughout this AC.

(22) Winch/hoist demonstration cycle (or "one cycle"). This is the complete extension and retraction of at least 95 percent of the actual cable length, or 100 percent of the cable length capable of being used in service (i.e., that would activate any extension/retraction limiting devices), whichever is greater.

(23) Winch/hoist load-speed combinations. Some winch/hoist designs are such that the extension/retraction speed slows down as the load increases or near the end of a cable extension. Other winch/hoist designs maintain a constant speed as the load is varied. In the latter design, the load-speed combination simply means the variation in load at the constant design speed of the winch/hoist.

d. Procedures. Because of the technical detail contained in subparagraph (d); the following index is provided to assist in locating specific compliance procedures.

(1) General Compliance Procedures for § 27.865: For compliance with § 27.865, the applicant should clearly identify the Parts 1 and 133 RLC's (i.e., the type of operations) that are being applied for and all applicable cargo types (i.e., NHEC or HEC) that will be used (See FIGURE AC 27.MG 12-1 following, for specific U.S. definitions). The structural loads and operating envelopes for each RLC class and applicable cargo type should be determined and used to formulate the flight manual supplement and basic loads report. The applicant should show by analysis, test, or both, that the rotorcraft structure, the external load attachment means, and (for HEC operations) the PCDS meet the specific requirements of §§ 27.865, 133.41, 133.43, 133.45, and the other relevant requirements of Part 27 for the proposed operating envelope.

In general, for compliance with § 27.865, the methods described by the following, procedural paragraphs are acceptable.

NOTE: It is possible, if approvable, to carry both HEC and NHEC externally, simultaneously as two separate external loads. However, in no case is it intended that

d(1) (continued)

the approved Maximum Internal Gross Weight be exceeded for any approved HEC configuration (or combined NHEC/HEC configuration) in normal operations.

(2) General Static Structural Substantiation Procedures for § 27.865(a): The following static structural substantiation methods should be used (paragraph d(21) describes the fatigue substantiation methodology).

(i) Static structural substantiation: The following methods of static structural substantiation should be employed.

(A) NHEC applications. In most cases a standard static analysis alone is acceptable to show compliance.

(B) HEC applications. If a safety factor of 3.0 or more on the yield strength of the weakest component in the QRS, PCDS, and attachment(s) load path is used, only an analysis is required for certification. Otherwise, both an analysis and a full-scale ultimate load test of relevant parts of the QRS, PCDS, and its attachments that form the HEC load path(s) should be submitted.

(ii) NHEC applications. For NHEC applications, use of 2.5 g vertical limit load factor ($N_{ZW}$) at the maximum substantiatable cargo load (which is typical for heavy gross weight NHEC hauling configurations) is required by § 27.865(a). This 2.5 g limit load factor is based on an engineering evaluation and a rationalization of § 27.337 for high gross weight applications.

(iii) HEC applications. For HEC applications, which typically involve lower gross weight configurations, a higher limit load factor is required to ensure that limit load is never exceeded in service. The higher load factor for HEC applications should be the analytically derived maximum vertical limit load factor for the restricted operating envelope being applied for or, as a conservative option, a vertical limit load factor of 3.5 g's (reference § 27.337). Unless a more rational proposal is received, for HEC applications where maximum operating gross weight for the external load is between design maximum weight and design minimum weight, linear interpolation can be used between $N_{ZW\ MIN}$ and $N_{ZW\ MAX}$ versus gross weight to determine the design limit load factor. In no case may the vertical limit load factor be less than 2.5 g's for any RLC application for HEC. For example, an HEC external load-carrying attachment or PCDS that is certified to a limit vertical load factor of 2.5 g's and is installed in a minimum gross weight configuration rotorcraft capable of generating a vertical limit load factor of 3.2 g's could experience ((3.2/[2.5 x 1.5]) x 100) = 85 percent of ultimate load (i.e., 128 percent of limit load) under worst case conditions with new external hardware. However, if factors such as wear and corrosion have affected the structural integrity of the external load carrying hardware, the limit and ultimate load capability may decrease significantly and the current design standard could be exceeded. Certification policy is not to exceed limit load in service. Therefore, to meet the requirement of § 27.865(a), the

d(2) (continued)

external load carrying hardware would need to be designed to a higher design standard (i.e., to withstand a limit load factor of 3.2g's.).

FIGURE AC 27.MG 12-1
U.S. OPERATIONAL (PART 133) ROTORCRAFT-LOAD COMBINATION VERSUS APPLICABLE CARGO TYPE DATA AND DEFINITION SUMMARY

| ROTORCRAFT-LOAD COMBINATION CLASS, CARGO TYPE | REQUIREMENT FOR CATEGORY "A" RATING AND OEI HOVER CAPABILITY |
|---|---|
| A, NHEC | NONE |
| A, HEC (SEE NOTE 2) | NONE |
| B, NHEC | NONE |
| B, HEC (SEE NOTE 2) | NONE |
| C, NHEC | NONE |
| C, HEC (SEE NOTE 2) | NONE |
| D, NHEC | NOT APPLICABLE (SEE NOTES 3 & 4) |
| D, HEC (SEE NOTE 1) | NOT APPLICABLE (SEE NOTE 3) |

NOTES:

1. A person(s) (passenger OTHER than a crewmember and/or OTHER than a person who is essential to the external-load operation), when carried as an external load, can only be carried as a Class D RLC. These persons are being carried (transported).

2. A person WHO IS a crewmember or a person WHO IS essential and directly connected with the external-load operation is not being carried (transported) as a passenger. They are, instead, part of the operation. These persons are considered as RLC Class A, B, or C HEC as appropriate to the operation.

3. HEC Class D operations are not allowed for Part 27 rotorcraft (Re: 133.45(e) restriction).

4. NHEC Class D operations are not applicable. An alternate NHEC operational configuration, using the same rotorcraft, would become either a Class A, B, or C NHEC operation.

5. OEI power settings should not be used for certification credit for normal operations. However, they are available for the OEI emergency scenarios for which approval has been granted whether or not a NHEC or HEC is involved.

6. FIGURE AC 27.MG 12-1 is based on analogous information contained in Chapter 96 of FAA Order 8700.1. In case of conflicting information, Order 8700.1 takes precedence.

<u>d(2) (continued)</u>

(iv) <u>Critical basic load determination</u>. For all § 27.865(a) applications, obtain the gross weight range limits, obtain the corresponding limit load factors ($N_{ZW}$), and statically substantiate the system, in accordance with the applied for external cargo application(s) [Reference d(1)], for the critical load(s). This determines the critical basic loads and associated operating envelope for the RLC's and applicable cargo types applied for.

(v) <u>Critical Structural Case</u>. For § 27.865(a) applications involving more than one RLC class and/or cargo type, structural substantiation is required only for the most critical case (Reference d(1)) if accurately determinable from analysis.

(vi) <u>Placards and markings</u>. For all § 27.865(a) applications, appropriate placards, markings, and flight manual restrictions should be provided for items such as operating procedures, load capacities, and operational restrictions for all external load systems and devices (see also, d(13)(iii)(B)). Each placard, marking, and flight manual supplement should be checked during TIA flight testing (see also, d(20)).

(vii) <u>Vertical Limit and Ultimate Load Factors</u>. For all § 27.865(a) applications, the basic vertical limit load factor ($N_{ZW}$) from d(2) is converted to ultimate load by multiplying the maximum applied load [i.e., the sum of the carrying device load, its supporting external structure load, and the maximum cargo load] by 1.5. (For restricted category approvals, see guidance in paragraph AC 27 MG 5.) This ultimate load is used to substantiate all existing structure affected by and all added structure associated with the load carrying device, its attachments, and its cargo. Casting factors, fitting factors, and/or other dynamic load factors are to be applied where appropriate. For all HEC applications, the minimum weight of each occupant carried externally should be assumed, for analysis or test purposes, to be that of the 95 percentile 202-pound man (reference MIL-STD-1472, "Human Engineering Design Criteria for Military Systems, Equipment, and Facilities").

<u>NOTE</u>: If the HEC is engaged in special work tasks that would typically employ devices of significant added weight (such as heavy backpacks or fire extinguishers), the weight of these devices should be added to that of the 95 percentile 202-pound man and used in the structural analysis.

(viii) <u>Winch/hoist system limit load</u>. For all § 27.865(a) applications that employ winch/hoist systems to raise or lower either an HEC or NHEC from a hover, or other phase of flight, the system limit load is required to be properly determined based on the characteristics of the winch/hoist system and its installation such as mechanical advantage, static strength of the winch/hoist, static strength of its installation, allowable cable length, and the payload for any operating scenario being applied for. One acceptable method of determining the winch/hoist system limit load for any RLC and any applicable cargo type is by the following procedure:

d(2) (continued)

NOTE: In cases where either winch/hoist cables or long-line cables are utilized, a new structural system is established. Certain characteristics of this system should be examined during certification to ensure that either no hazardous failure modes exist or that they are acceptably minimized. For example, the cable or long line may (in conjunction with the rotorcraft) exhibit an unacceptable natural frequency that could be excited by sources internal to the overall structural system (i.e., the rotorcraft) or by sources external to the system. Another example is the loading effect of the cable or long line acting as a spring between the rotorcraft and the suspended external load or ground, respectively, either during flight or (when in ground contact) at the time of load release. These conditions should be reviewed and, if potentially hazardous, minimized by controlling relevant overall structural system parameters such as cable length.

(A) Determine the basic loads that fail and unspool the winch/hoist or its installation, respectively.

NOTE: This determination should be based primarily on static strength; however, any dynamic load magnification factors that are significant should be accounted for.

(B) Select the lower of the two values from (i) as the ultimate load of the winch/hoist system installation.

(C) Divide the selected ultimate load by 1.5 to determine the true structural limit load of the system.

(D) Determine the manufacturer's approved (or applicants applied for) "limit design safety factor." Divide this factor into the true structural limit load (from (c) above) to determine the winch/hoist system's working (or placarded) limit load. As a minimum, this factor should equal or exceed the value of all the factors defined under d(2)(vii) when multiplied together.

NOTE: Most winch/hoist manufacturers either use a "Limit design safety factor" of 4 to 5 on ultimate to determine their placarded limit load [i.e., allowable LL = UL/(4 to 5)]; or they use a safety factor of approximately 3 on yield to determine their placarded limit load [i.e., allowable LL = true LL/3.0]. In some cases, the load is swung through a cone of a 30 degree half apex angle. Typical structural design criteria is for the winch/hoist to remain in one piece and still function after experiencing true limit load, and to remain in one piece, but not necessarily function, after experiencing true ultimate load. These relatively large structural safety factors are used to conservatively account for phenomena such as casting factors in flight dynamic loading conditions, and wear and tear between phased inspections.

(E) Compare the system's derived limit load to the applied for one "g" payload multiplied by the maximum downward vertical load factor ($N_{ZWMAX}$) from paragraph d(2) to determine the critical payload's limit value.

d(2) (continued)

(F) If the critical limit payload is equal to or less than the system's derived limit load, the installation is structurally approvable as presented.

NOTE: For HEC applications, the critical limit payload should be equal to or more than the combined weight of the PCDS and its maximum number of passengers (See also d(2)(vii), for passenger weight values).

(G) If the critical limit payload exceeds the system's derived limit load, then one of the following options should be considered:

(1) Disapproval.

(2) Application for exemption.

(3) Reduction of the applied for critical limit payload to less than or equal to the system's derived limit load.

(4) Redesign of the winch/hoist system (and installation) to increase its derived limit load to equal to or greater than the critical payload.

(5) A combination of options *(3)* and *(4)*.

(6) Approvable operating restrictions to reduce $N_{ZWMAX}$ and the corresponding critical limit payload to less than or equal to the system's derived limit load.

NOTE: Additional combinations of external load and operating restrictions may be subsequently approved under operational requirements as long as the FAR 27 structural limits of the basic certification are not exceeded, (i.e., equivalent safety is maintained).

(3) Functional Reliability and Durability Compliance Procedures for Winch/Hoist Systems under §§ 27.865(b)(3)(i) and (c)(2): It is recommended that winch/hoist systems and their installations in the rotorcraft should be designed, certified, and demonstrated as follows:

(i) General. Winch/hoist systems should be approved to acceptable aircraft industry standards. These standards and any related manufacturer's certificates of production/qualification, thereto, should be presented by the applicant as part of the approval package. Two typical winch/hoist approval scenarios exist. They are:

(A) For established, previously approved winch/hoist unit designs that are to be placed in a new rotorcraft installation, certification credit (to Amendment 27-36) for the unit itself can be given based on a successful unit design review (or a

d(3) (continued)

manufacturer's statement-of-certification accompanied by an FAA Form 8110-3 with appropriate DER approvals) that shows proper previous approval and that shows no new design changes have been made that adversely affect the reliability or function of the unit (i.e., an update of the Failure Modes and Effects Analysis (FMEA)). If so approved, then only the winch/hoist installation need be approved during certification.

(B) For new winch/hoist unit designs, the unit should be either certified to a standard aircraft industry specification that has been previously and successfully used to certify winch/hoist units, or an equivalent specification should be developed and met during the certification process.

NOTE: Background information. There are no generic industry, FAA, or military specifications currently available to apply to winch/hoist units. Thus, the detail specifications for winch/hoist unit certifications are typically generated as follows: 1) For military applications, the military dictates the basic winch/hoist unit specifications in the prime aircraft development specification. The airframe manufacturer then typically either writes or has a winch/hoist vendor write a detailed unit certification specification that includes all necessary, detailed certification criteria; 2) For commercial applications (that install the winch/hoist unit under either a new or amended type certificate or a supplemental type certificate), the airframe manufacturer typically either writes a detailed winch/hoist unit specification or has a vendor (usually the winch/hoist unit manufacturer) write the detailed certification specifications and procedures (based on the unit manufacturer's experience and the customer needs during the installation process). For either method, the FAA approves and adds the specification to the type data file during the installation approval process.

(ii) NHEC applications. The winch/hoist/rescue hook system should be reliable for the phases of flight in which it is operable, unstowed, partially unstowed and/or in which NHEC is carried. The primary electrical and/or mechanical failure modes that should be identified and minimized are unintended load release by any means, and loss of continued safe flight and landing capabilities due to a winch/hoist/rescue hook system failure. However, any other winch/hoist/rescue hook system failure that could lead to a catastrophic failure mode for the rotorcraft should also be minimized. Loss of winch/hoist operational control should also be considered. The reliability of the system should be demonstrated by completion and approval of the following:

NOTE: It is assumed that only 1 winch/hoist cycle will typically occur per flight. This rationale has been used to determine the 10 demonstration cycles of d(3)(ii)(B) below. However, if a particular application should potentially involve more than one winch/hoist cycle per flight, then the number of demonstration cycles of d(3)(ii)(B) should be increased accordingly.

d(3) (continued)

(A) A winch/hoist/rescue hook system level FMEA that identifies and minimizes any potential catastrophic failures should be conducted.

(B) Unless a more rational test method is presented and approved, a repetitive test of all functional devices in accordance with d(3)(vii) that exercises the entire system's functional parameters at least 10 times should be conducted. These repetitive tests may be conducted on the rotorcraft, or by using a bench simulation that accurately replicates the rotorcraft installation.

NOTE: If a more rational method of compliance is presented that clearly shows that an equivalent level of safety can be achieved in fewer than 10 system test cycles, the method of compliance may be acceptable.

NOTE: For properly certified winch/hoist units (Ref. d(3)(i)) that have established acceptable service histories, full certification credit for the unit itself may be given. However, each new installation is required to be approved individually, unless the installation is either identical or similar to an existing approved installation with an acceptable service history. If the new installation is only similar to an acceptable existing installation, then, for a similarity approval, all differences should be clearly stated, rationalized, analyzed, and/or tested to show they do not adversely affect the new installation (i.e., equivalent safety should be provided).

(C) A winch/hoist unit environmental qualification program that includes consideration of high and low temperatures (typically -40F to +150F), altitudes to 12,000 feet, humidity, salt spray, sand and dust, vibration, shock, rain, fungus, and acceleration should be conducted. Testing should be conducted in accordance with RTCA/DO-160 and/or MIL-STD-810 for high and low temperature tests and for vibrations. The winch/hoist manufacturers should submit a test plan and follow-on test reports to the applicant and FAA following completion of qualification. It is intended that the winch/hoist itself either be prequalified to the EMI and lightning threat levels specified for NHEC and/or HEC or that it be qualified as part of the entire onboard QRS to these threat levels.

(D) All instructions and documents necessary for continued airworthiness should be provided.

(E) The methods of compliance in other relevant paragraphs of this AC or equivalent methods should be employed.

(iii) HEC applications. The winch/hoist/rescue hook system should be reliable for the phases of flight in which it is operable, unstowed, partially unstowed and/or in which HEC is carried. The primary electrical and/or mechanical failure modes that should be identified and minimized are unintended load release by any means and loss of continued safe flight and landing capability due to a winch/hoist/rescue hook

d(3) (continued)

system failure. However, any other winch/hoist/rescue hook system failure that could lead to a catastrophic failure mode for the rotorcraft should also be minimized. The winch/hoist should be disabled (or an overriding, fail-safe mechanical safety device such as either a flagged removable shear pin or a load-lowering brake should be utilized) to prevent inadvertent load unspooling or release during any extended flight phases which involve HEC and in which winch/hoist operation is not intended. Loss of winch/hoist operational control should also be considered. The reliability of the system should be demonstrated by completion and approval of the following:

NOTE: It is assumed that only one winch/hoist cycle will typically occur per flight. This rationale has been used to determine the 30 demonstration cycles of d(3)(iii)(B) below. However, if a particular application should potentially involve more than one winch/hoist cycle per flight, then the number of demonstration cycles of d(3)(iii)(B) should be increased accordingly.

(A) A winch/hoist/rescue hook system level FMEA that identifies and minimizes any potential catastrophic failures should be conducted.

(B) Unless a more rational test method is presented and approved, a repetitive test of all functional devices in accordance with d(3)(vii) that exercises the entire system's functional parameters at least 30 times should be accomplished. These repetitive tests may be conducted on the rotorcraft or by using a bench simulation test that accurately replicates the rotorcraft installation.

NOTE: If a more rational method of compliance is presented that clearly shows that an equivalent level of safety can be achieved in fewer than 30 system test cycles, the method of compliance may be acceptable.

NOTE: For properly certified winch/hoist units (Ref. d(3)(i)) that have established acceptable service histories, full certification credit for the unit itself may be given. However, each new installation is required to be approved individually, unless the installation is either identical or similar to an existing approved installation with an acceptable service history. If the new installation is only similar to an acceptable existing installation, then for a similarity approval, all differences should be clearly stated, rationalized, analyzed, and/or tested to show they do not adversely affect the new installation (i.e., equivalent safety should be provided).

(C) A winch/hoist system environmental qualification program that includes consideration of high and low temperatures (typically -40F to +150F), altitudes to 12,000 feet, humidity, salt spray, sand and dust, vibration, shock, rain, fungus, and acceleration should be conducted. Testing should be conducted in accordance with RTCA/DO-160 and/or MIL-STD-810 for high and low temperature tests and for vibrations. The winch/hoist manufacturers should submit a test plan and follow-on test reports to the applicant and FAA following completion of qualification. It is intended that the winch/hoist itself either be prequalified to the EMI and lightning threat levels specified for NHEC and/or HEC or that it be qualified as part of the entire onboard QRS to these threat levels.

(D) All instructions and documents necessary for continued airworthiness should be provided.

(E) The methods of compliance in other relevant paragraphs of this AC or equivalent methods should be employed.

(iv) Cable attachment. Either the cable should be positively attached to the winch/hoist drum and the attachment should have ultimate load capability, or equivalent means should be provided to minimize the possibility of inadvertent, complete, cable unspooling.

NOTE: Even though the placarded winch/hoist system load rating is much less, most winch/hoist cables are rated to a minimum of 3,300 lbs. limit load. Typically, cables have a neutral twist to minimize load oscillation.

(v) Cable length and marking. A length of cable nearest the cable's attachment to the winch/hoist drum should be visually marked to indicate to the operator that the cable is near full extension. The length of cable to be marked is a function of the maximum extension speed of the system and the operator's reaction time needed to prevent cable run out. It should be determined during certification demonstration tests. In no case should the length be less than 3 1/2 drum circumferences.

(vi) Cable stops. Means should be present to automatically stop cable movement quickly when the system's extension and retraction operational limits are reached.

(vii) Winch/hoist system load-speed combination ground tests. The load versus speed combinations of the winch/hoist should be demonstrated on the ground (either using an accurate engineering mock-up or a rotorcraft) by showing repeatability of the no load-speed combination, the 50 percent load-speed combination, the 75 percent load-speed combination and the 100 percent (i.e., system rated limit) load-speed combination. If more than one operational speed range exists, the preceding tests should be performed at either all speeds, or at the most critical speed if it can be determined. [Reference d(3)(ii)(B) and d(3)(iii)(B)].

(A) At least 1/10 of the demonstration cycles (see definition) should include the maximum aft angular displacement of the load from the drum, applied for under § 27.865(a).

d(3) (continued)

(B) A minimum of six consecutive, complete operation cycles should be conducted at the system's 100 percent (i.e., system limit rated) load-speed combination.

(C) In addition, the demonstration should cover all normal and emergency modes of intended operation and should include operation of all control devices such as limit switches, braking devices, and overload sensors in the system.

(D) All quick disconnect devices and cable cutters should be demonstrated at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of system limit load or at the most critical percent, if it can be determined.

NOTE: Some winch/hoist designs have built-in cable tensioning devices that function at the no load-speed combination, as well as at other load-speed combinations. This device should be demonstrated to work during the no load-speed and other load-speed cable-cutting demonstrations.

(E) All electrical and mechanical systems and load release devices for any jettisonable NHEC or HEC RLC should be shown to be reliable by both analysis and by testing done in accordance with the combined criteria of d(8) and this paragraph.

(F) Any devices or methods used to increase the mechanical advantage of the winch/hoist should also be demonstrated.

d(3) continued

(G) During a portion of each demonstration cycle, the winch/hoist should be operated from each station from which it can be controlled.

NOTE: A reasonable amount of starting and stopping during demonstration cycles is acceptable.

(viii) Winch/hoist system continued airworthiness. The design life of the winch/hoist system and any limited life components should be clearly identified, and the Airworthiness Limitations Section of the maintenance manual should include these requirements. For STC's, a maintenance manual supplement should be provided that includes these requirements.

NOTE: Design lives of winch/cable systems are typically between 5,000 to 8,000 cycles. One major manufacturer uses a specification requirement of 7,500 cycles. Some winch/hoist systems have usage time meters installed. Others may have cycle counters installed. Cycle counters should be considered for HEC operations and high load or other operations that may cause low-cycle fatigue failures (see also d(24)).

d(3) (continued)

(ix) Winch/hoist system manual proofing. Operating manuals, flight manuals, maintenance manuals, and associated placards should be used and proofed during the demonstration.

(x) Winch/hoist system flight tests. An in-flight demonstration test of the winch/hoist system should be conducted for helicopters designed to carry NHEC or HEC. The rotorcraft should be flown to the extremes of the applicable maneuver flight envelope and to all conditions that are critical to strength, maneuverability, stability, and control, or any other factor affecting airworthiness. Unless a lesser load is determined to be more critical for either dynamic stability or other reasons; the maximum winch/hoist system rated load or, if less, the maximum load requested for approval (and the associated limit load data placards) should be used for these tests. The minimum winch/hoist system load (or zero load) should also be demonstrated in these tests. (See also d(19)(x).)

(4) Compliance Procedures for Cargo Hooks (or Equivalent Devices) and their Related Systems under §§ 27.865(a), (b), and (c): Cargo hooks or equivalent devices and their related systems, used for any external cargo type, should be approved to acceptable aircraft industry standards. These standards and any related manufacturer's certificates of production/qualification, thereto, should be presented by the applicant as part of the approval package.

(i) General. Cargo hook systems should have the same reliability goals and should be functionally demonstrated under critical loads for NHEC, HEC, or both in a manner identical to winch/hoist/rescue hook systems (reference d(3)). All engagement and release modes should be demonstrated. If the hook is used as a quick-release device, then release of critical loads should be demonstrated under conditions that simulate maximum allowable bank angles and speeds and any other critical operating conditions. Demonstration of any relatch features and any safety or warning devices should also be conducted. Demonstration of actual in-flight emergency quick-release capability may not be necessary if the quick-release capability can be acceptably simulated by other means.

NOTE: Cargo hook manufacturers specify particular shapes, sizes, and cross sections for lifting eyes to ensure compatibility with their hook design (e.g., Breeze Eastern Service Bulletin CAB-100-41). Experience has shown that, under certain conditions, a load may inadvertently hang up because of improper geometry at the hook/eye interface that will not allow the eye to slide off an open hook as intended. See also the discussion of hook dynamic roll out (i.e., the converse-an unintentional load release) under d(8).

NOTE: Some cargo hook systems may employ two or more cargo hooks for fail safety (i.e., after a failure of any single hook the remaining system is capable of carrying limit load). These systems are approvable. However, loss of load by any single hook should

d(4) (continued)

be shown to not result in loss of control of the rotorcraft. In a dual hook system, if the hook itself is the quick-release device (i.e., if a single release point does not exist in the load path between the rotorcraft and the dual hooks), the pilot should have a dual PQRS that includes selectable, collocated individual quick releases that are independent for each hook used. A BQRS should also be present for each hook. For cargo hook systems with more than two hooks, either a single release point should be present in the load path between the rotorcraft and the multiple hook system or multiple PQRS/BQRS's should be present. The former arrangement would only require a single PQRS and BQRS. A single release point can be a single or multiple cable cutter or release.

NOTE: If possible (within the rotorcraft configuration's restrictions), a simple set of approved cable cutters can satisfy the requirement for either a PQRS or BQRS in a cargo hook system installation. However, in many cargo hook system installations, unless a special access panel or an equivalent means is present, a crewman typically cannot reach and cut the cable with a standard set of cable cutters.

(ii) NHEC cargo hook systems. For jettisonable NHEC applications, each cargo hook-

(A) Should have a sufficient amount of slack in the control cable to permit cargo hook movement without tripping the hook release.

(B) Should be shown to be reliable in a manner identical to winch/hoist systems under d(3)(ii).

(iii) HEC cargo hook systems. For jettisonable HEC applications, each cargo hook-

(A) Should have a sufficient amount of slack provided in the control cable to permit cargo hook movement without tripping the hook release.

(B) Each cargo hook should be shown to be reliable in a manner identical to winch/hoist systems under d(3)(iii).

(C) Unless the cargo hook is to be the primary quick-release device, each cargo hook should be designed such that the load cannot be inadvertently released by operationally induced loads. For example, a simple cargo hook should have a one-way, spring loaded gate (i.e., "snap hook") that allows load attachment going into the gate but does not allow the gate to open (and subsequently lose the HEC) when an operationally induced load is applied in the opposite direction. For HEC applications, cargo hooks that double as quick-release devices should be carefully reviewed to ensure they are reliable. Paragraph d(8)(iii) discusses means of increasing the reliability of devices such as cargo hooks for HEC applications.

d(4) continued

(iv) Other cargo hook system safety requirements. DOE, EPA, OSHA, and other Government Agencies may have special safety requirements for cargo hook design over and above the FAR's, such as a dual cargo hook requirement for certain HEC operations under multi-agency regulation.

(5) Compliance Procedures for Maximum Limit Load Magnitude Determination for all Jettisonable RLC Applications under §27.865(a): For all jettisonable RLC applications for any applicable cargo type seeking § 27.865(a) approval, the maximum limit external load for which certification is requested (even though it may otherwise be much less than the maximum system capacity; e.g., cargo hook capacity, etc.) should not exceed the rated capacity of the QRS release devices used in the applicant's design or, for HEC, the rated capacity of either the QRS devices, the PCDS, or its attachments--whichever is less. Relevant parts of the QRS and the entire PCDS should be analyzed and strength tested, with FAA witness, or otherwise structurally substantiated to determine their allowable limit load capacity (reference (d)(2)) if not previously FAA approved or produced to a recognized, approvable industry and/or military standard.

(6) Compliance Procedures for Basic Loads Analysis under § 27.865(a): For all jettisonable RLC applications of any applicable cargo type seeking compliance with § 27.865(a), the maximum ultimate external load is required to be applied at sling-load-line to rotorcraft vertical axis (Z axis) angles up to 30 degrees, in any geometric direction, in substantiating analyses or tests. The 30-degree angle may be reduced in some or all directions if impossible to obtain due to physical constraints or operating limitations.

(i) Maximum cable angle. The maximum allowable cable angle (from either a winch/hoist/rescue hook, cargo hook system, or other acceptable system configuration) should be determined and approved (reference d(3)). The angle approval should be based on structural requirements, mechanical interference limits, and flight handling characteristics over the most critical conditions and combinations of conditions in the approved flight envelope.

NOTE: In an emergency, in some cases, the combined design of the rotorcraft and the suspended system may be such that the 30-degree angle can be exceeded, to a limited extent, without catastrophic failure. The flight manual should clearly state this maximum angle value (in the aft direction relative to the Rotorcraft Z axis; for both maximum and minimum cable lengths) that should never be exceeded in any emergency in order to minimize the hazard of a related, catastrophic failure.

(ii) 30-degree maximum angle value. In no case should the design angle for HEC exceed 30 degrees from the vertical rotorcraft axis (i.e., Z axis). If the angle is reduced, appropriate placards and flight manual changes are required (reference d(2)).

d(6) (continued)

(iii) Special cases. In some special NHEC jettisonable RLC operations, such as wire stringing, the 30-degree angle can be exceeded. These cases should be approved on a case-by-case basis by an engineering certification office. An issue paper should be used to document the exact limit operational parameters determined during certification. This is necessary because of the large variability of external loads and flight maneuvers that should be considered to establish safe operating limits for these operations. As a minimum, the maximum allowable load, the maximum allowable cable angles, the maximum flight envelope, the necessary limitation placards, and the necessary RFM procedures/restrictions should be accurately determined and documented. The maximum allowable structural load envelope should be clearly identified and determined. The fatigue spectrum created by this load envelope and its frequency of use (considering in particular the possibility of low cycle fatigue failures and significantly reduced component life limits) should be clearly identified, documented, and approved.

NOTE: There are two typical configurations that have been previously approved for attaching jettisonable NHEC loads in operations such as wire stringing. They are:

Weighted-Line Sidepull Configuration. In this method, a heavy dead weight is suspended below the cargo hook. The sidepull line (jettisonable load) is then attached to the dead weight or just above the weight. The rotorcraft then proceeds in forward or sideward flight and the weight pulls the sidepull-line (jettisonable load). This method is very inefficient for payload utilization since much of the rotorcraft load capacity is used to move the dead weight rather than pulling the sidepull line.

Load limiting devices such as approved fuseable/frangible links should be considered for these applications to ensure limit load is not exceeded in service.

Sidepull-Fixture Sidepull Configuration. In this method, a QRS device is attached at the side of the rotorcraft (or in another equivalently functional location) and is arranged so the sidepull-line's (jettisonable load's) load path is through (or nearly through) the rotorcraft center of mass at a typical working fuel condition. This configuration is more payload efficient and has much better controllability characteristics than the deadweighted sidepull-line configuration. At least one STC has been issued for a sidepull-fixture configuration for use in operations.

(7) Compliance Procedures for General QRS Certification and Installation under § 27.865(b) and § 27.865(c): For jettisonable RLC's for any applicable cargo type, a PQRS is mandated that features an approved primary quick-release device to be installed on one of the pilot's primary controls, or in an equivalently accessible location. The use of an "equivalent accessible location is intended to be applied/reviewed on a case-by-case basis and to be used only where equivalent safety is clearly maintained. A BQRS with a backup quick-release device is also required. The PQRS, the BQRS, and their load release devices and subsystems (such as

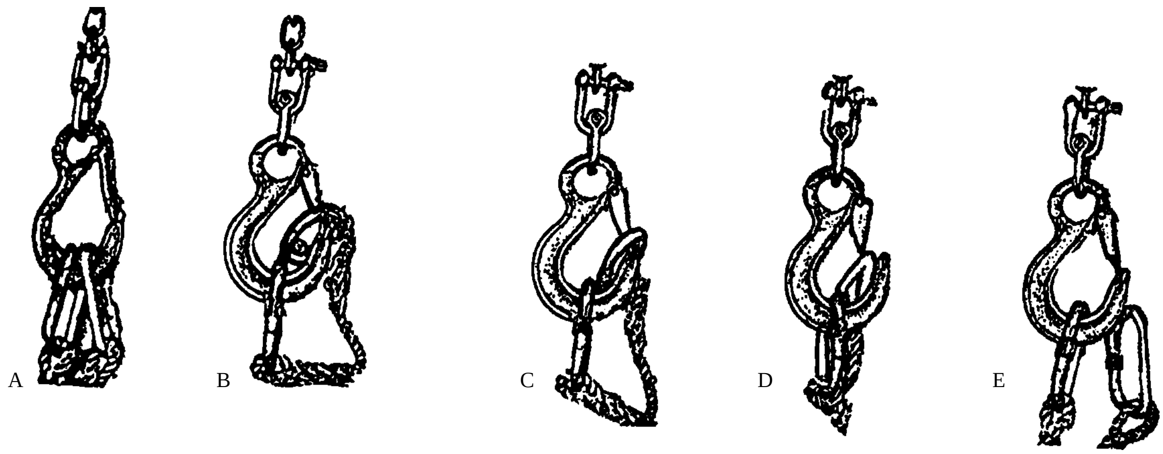
d(7) (continued)

electronically actuated guillotines) should be separate (i.e., physically, systematically, and functionally redundant). Also, for the BQRS, the backup release control and release need not be mechanical. It is intended that less sophisticated BQRS's and load release devices (such as manual cable cutters) would, if separate, be acceptable. However, if separate devices of this type are to be used, they should be listed in the flight manual as a required device and have a dedicated, placarded storage location. Each quick-release device should be designed and located to allow the pilot or a crewmember to accomplish external cargo release without hazardously limiting the ability to control the rotorcraft during emergency situations. The flight manual should reflect the requirement for a crewmember and the related functions. For jettisonable HEC operations, further QRS requirements are contained in § 27.865(c). (See paragraphs d(8), d(9) and d(12) of this AC.) No PQRS or BQRS should require more than 30 seconds from the time an emergency is declared and the PQRS or BQRS quick release device is located and activated until the NHEC or HEC load is released. This should be clearly demonstrated in certification.

(8) Compliance Procedures for Reliability Determination for Jettisonable NHEC and HEC QRS's and Devices under § 27.865(b)(3): Jettisonable NHEC QRS's and devices and jettisonable HEC QRS's and devices are required to be reliable. One acceptable method of achieving the intended reliability goals is described as follows:

NOTE: For both NHEC and HEC designs, the phenomena of hook dynamic roll out should be considered, to the maximum practicable extent, to ensure that QRS reliability goals are not compromised. This is of utmost concern for HEC applications. Hook dynamic roll-out occurs during certain ground handling and flight conditions that may allow the lifting eye to work its way out of the hook (Reference FIGURE AC 27.MG 12-1).

Some commercial hook shape and keeper designs are quite prone to hook dynamic roll-out. Military Standard hook designs have not been as prone to hook dynamic roll-out as have some commercial designs. Hook dynamic roll-out typically occurs when either the RLC's sling or harness is not properly attached to the hook, is blown by down draft, is dragged along the ground, is dragged through the water; or is otherwise placed into the dangerous hook/eye configuration, shown by FIGURE AC 27.MG 12-2. This can occur during ground handling or can be caused by relative motion of the hook and eye in flight. The potential for hook dynamic roll-out can be minimized in design by specifying particular hook-and-eye shape and hook-and-eye cross-section combinations. For non-jettisonable RLC's, a push-pull pin (or an equivalent device) can be used to lock the hook keeper in place during operations. The hook dynamic roll-out service history of any off-the-shelf components to be utilized should also be reviewed to minimize the use of potential "bad-actors."




| **STEP A** | **STEP B** | **STEP C** | **STEP D** | **STEP E** |
|---|---|---|---|---|
| **Two carabiners securely in the hook.** | **Carabiner slides up and becomes mispositioned across jaw of hook.** | **Load on carabiner applied between keep and lip of hook.** | **Keeper pushes carabiner over tip of hook.** | **Carabiner becomes free and the Load is inadvertently released.** |

**FIGURE AC 27.MG 12-2: SEQUENTIAL SIMULATION OF HOOK DYNAMIC ROLL-OUT**

(i) Jettisonable NHEC designs. The QRS and the load suspension and retention designs should be reliable. The primary electrical and/or mechanical failure modes that should be identified and minimized are load release by any means and loss of continued safe flight and landing capability due to a QRS failure. However, any other failure that could lead to a catastrophic failure mode for the rotorcraft and its occupants should also be identified and minimized. The reliability of the system should be demonstrated by completion and approval of the following:

(A) A QRS level FMEA that identifies and minimizes any potential catastrophic failures.

(B) A repetitive test of all functioning devices that affect or comprise the QRS and that tests all critical conditions or combinations of critical conditions at least 10 times each, using both the primary and backup QRS subsystems.

(C) An environmental qualification program such as that described in d(3)(ii)(C).

(D) Use of the methods of compliance in other relevant paragraphs of the AC or equivalent methods.

(ii) Jettisonable HEC designs. The QRS and the load suspension and retention designs should be reliable. The primary electrical and/or mechanical failure

d(8) (continued)

modes that should be identified and minimized are unintended load release by any means and loss of continued safe flight and landing capability due to a QRS failure. However, any other failure that could lead to a catastrophic failure for the rotorcraft and its occupants (either internal, external, or both) should also be identified and minimized. The reliability of the system should be demonstrated by completion and approval of the following:

(A) A QRS level FMEA that identifies and minimizes all failure modes, including any potential catastrophic failures.

(B) A repetitive test of all functioning devices that affects or comprises the QRS and that tests all critical conditions or combinations of critical conditions at least 30 times each, using both the primary and backup subsystems.

(C) An environmental qualification program such as that described in d(3)(ii)(C).

(D) Use of the methods of compliance in other relevant paragraphs of the AC or equivalent methods.

(iii) Special Cases. In some cases, an acceptable reliability for jettisonable HEC operations can be shown by temporarily deactivating a particular QRS, PQRS, and/or BQRS subsystem used for NHEC that is not otherwise reliable enough for use with jettisonable HEC. For example, this could be accomplished by adding an approved reliable QRS device for HEC such as alternate, ultimate load path across a relatively low reliability, jettisonable NHEC quick-release device or by adding another reliable fail-safe device (e.g., adding an approved, reliable safety strap as a parallel ultimate load path). The same reliability goal for HEC use could also be achieved by adding another, reliable fail-safe device such as a safing pin to an electronically actuated guillotine cutter to upgrade the system reliability to be acceptable for HEC carriage. For some designs, cargo hooks can be made more reliable by wiring them shut with an approved gage of safety wire. All other regulatory requirements for HEC carriage must still be met after an approved modification of the QRS to achieve the reliability necessary for HEC carriage. In the preceding examples, a replacement PQRS such as an additional set of cable cutters would need to be added to provide a complete QRS (i.e., both the PQRS and the BQRS must be present). In all cases, an HEC reliability demonstration in accordance with d(8)(ii) should be conducted and approved. Operational acceptability of these special case configurations also needs to be demonstrated.

(iv) Other load release types. In some current configurations, such as those used for high line operations, a load release may be present that is not on the rotorcraft but is on the PCDS itself. Examples are a tension release device that lets out

d(8) (continued)

line under an operationally induced load or a personal rope cutter. These devices are acceptable if:

(A) The off-rotorcraft release is considered a "third release"; i.e., an approved QRS (i.e., PQRS and BQRS) is present on the rotorcraft;

(B) The release meets other relevant requirements of § 27.865 and the methods of this AC or equivalent methods; and

(C) The release has no operational or failure modes that would affect continued safe flight and landing under any operations, critical failure modes, conditions, or combination of either.

(9) Compliance Procedures for Electromagnetic Interference under § 27.865(b)(3)(ii): Protection of any critical portions of the QRS against potential internal and external sources of electromagnetic interference (EMI) and lightning is required. This is necessary to prevent inadvertent load release from sources such as lightning strikes, stray electromagnetic signals, and static electricity.

NOTE 1: For "on-the-shelf" QRS system components (that may be used on different rotorcraft and in different installation configurations in the same rotorcraft) a one-time bench test, if FAA approved, can be used to test the EMI capability of the component itself. However, the EMI effect of each individual installation must be taken into account on a case-by-case basis when certifying the component's installation. This is especially critical for HEC applications.

(i) Jettisonable NHEC systems - should be able to absorb a minimum of 20 volts per meter (i.e., CAT U) RF field strength per RTCA/DO-160.

(ii) Jettisonable HEC systems[1] - should be able to absorb a minimum of 200 volts per meter (i.e., CAT Y) RF field strength per RTCA/DO-160.

NOTE 1: These RF field threat levels may have to be increased for certain special applications such as microwave tower and high voltage high line repairs. Separate criteria for special applications under multi-agency regulation (such as IEEE/OSHA standards) should also be addressed, as applicable, during certification. When necessary, an issue paper can be used to establish a practicable level of safety for specific high voltage or other special application conditions. For any devices or means added to meet multi-agency regulations, their failure modes should not have an adverse effect on flight safety. Other certification authorities may require higher RF field threat levels than those required by § 27.865 (e.g., the European Joint Aviation Authorities Interim HIRF policy).

d(9) (continued)

NOTE 2: An approved, standard rotorcraft test that includes the full HIRF frequency/amplitude external and internal environments on the QRS and PCDS (or the entire rotorcraft including the QRS and PCDS) could be substituted for the jettisonable NHEC and HEC systems tests defined by d(9)(i) and d(9)(ii), respectively, as long as the RF field strengths directly on the QRS and PCDS are shown to equal or exceed those of d(9)(i) and d(9)(ii).

NOTE 3: The EMI levels specified in d(9)(i) and d(9)(ii) are total EMI levels to be applied to the QRS (and/or effected QRS component) boundary. The total EMI level applied should include the effects of both external EMI sources and internal EMI sources. All aspects of internally generated EMI should be carefully considered including peaks that could occur from time-to-time due to any combination of on-board systems being operated. For example, special attention should be given to EMI from winch operations that involve the switching of very high currents. Those currents can generate significant voltages in closely spaced wiring that, if allowed to reach some squib designs, could activate the device. Shielding, bonding and grounding of wiring associated with operation of the winch and the quick-release mechanism should be clearly and adequately evaluated in design and certification. This evaluation may require testing. One acceptable test method to demonstrate adequacy of QRS shielding, bonding and grounding, would be to actuate the winch under maximum load together with likely critical combinations of other aircraft electrical loads and demonstrate that the test squibs (that are more EMI sensitive than the squibs specified for use in the QRS) do not inadvertently operate during the test.

(10) General Compliance Procedures for HEC Applications under § 27.865(c): For HEC applications, the safety requirements for HEC carriage for all applicable RLC's are addressed. This ensures that HEC certification requirements are clearly and properly identified.

(11) General Compliance Procedures for Jettisonable HEC Operations under § 27.865(c)(1): For jettisonable HEC operations, it may be required by Operations Requirements, that the rotorcraft meet the Category A engine isolation requirements of Part 29 and that the rotorcraft have OEI OGE hover performance capability in its approved, jettisonable HEC weight, altitude, and temperature envelope. OEI vertical climb capability may be needed in some operational circumstances for flight safety. Such instances should be identified and the necessary OEI vertical climb capability assessed and verified during the certification process.

(12) Compliance Procedures for QRS's under § 27.865(c)(1): For jettisonable HEC operations, both the PQRS and BQRS are required to have a DAD (i.e., see definitions, they are required to have a sequential control with two distinct actions) for external cargo release. Two distinct actions are required to provide a higher level of safety to minimize inadvertent jettison of HEC. The DAD is intended for emergency use only during the phases of flight that the HEC is carried (and/or retrieved) externally. The

d(12) (continued)

DAD can be used for both NHEC and HEC operations. However, because it can be used for HEC, its continued airworthiness should be carefully reviewed and documented in accordance with prescribed (or mandated) instructions. The DAD (i.e., either the primary or backup release) can be operated by the pilot from a primary control or, after a command is given by the pilot, by a crewmember from a remote location. If the backup DAD is a cable cutter, it should be properly secured but readily accessible to the crewmember intended to use it.

NOTE 1: OEI power settings should not be used for certification credit for normal operations. However, they are available for the OEI emergency scenarios for which approval has been granted whether or not a NHEC or HEC is involved. For determination of the maximum rotorcraft gross weight approved for Class D operations (i.e., HEC operations performed with a multiengine rotorcraft capable of OEI HOGE), it is intended that use of the maximum OEI Power approved for the rotorcraft engine and drive system be allowed after failure of the critical engine (when applied in conjunction with an approved Class D operating procedure). Thus, it would be acceptable to base the required OEI/OGE hover performance capability for a Class D operation on a 30-second OEI power rating if the operator can demonstrate that the HEC can be safely transitioned to a flight condition where the HEC can be retrieved inside the rotorcraft for an execution of a normal OEI landing. If the specific operation for which the Class operation approval is requested does not provide for safe disposition of the HEC when using a time limited OEI rating, the Class D operation gross weight should be limited to a gross weight where OEI/OGE hover capability can be demonstrated for a continuous time period.

(13) Compliance Procedures for PCDS's under § 27.865(c)(2): For all HEC applications, an approved PCDS is required. The PCDS is either required to be previously approved or is required to be approved during certification (reference d(14) for information on current designs). In either case, its installation should be approved. PCDS designs can vary from simple single occupant donut "lifesaver" devices to relatively complex multiple occupant cages or gondolas. However, the basic occupant hazard design philosophy is the same. It is to provide injured (conscious or possibly unconscious) occupants or uninjured occupants the level-of-safety necessary to minimize the possibility of any further or new injuries under any flight conditions that could occur while they are carried external to the rotorcraft.

(i) Static strength. The PCDS should be substantiated for the allowable ultimate load and loading conditions as determined under paragraphs d(2) through d(5) above.

(ii) Fatigue. The PCDS is required to be substantiated for fatigue in accordance with § 27.865(f) (Reference d(21)).

d(13) (continued)

(iii) Personnel safety. For each PCDS design, a documented design evaluation should be submitted by the applicant (and presented to the Certification Authority) that ensures that the necessary level of personnel safety is provided (i.e., all potential, relevant occupant hazards are acceptably minimized). As a minimum, the following should be evaluated.

NOTE: It is intended that the evaluation should be comprehensive. However, it is not necessarily intended that the PCDS be required to have all the personnel safety design features of, for example, a transport aircraft interior. Only those personnel safety design features necessary to minimize new or further injury to PCDS occupants during the relatively short time interval the PCDS is utilized on a given mission are necessary.

(A) The PCDS should be easily and readily ingressed or egressed.

(B) It should be placarded for proper capacity, internal arrangement/location of occupants, and ingress and egress instructions (See also, d(2)(vi)).

(C) For door latch fail-safety, more than one fastener or closure device is recommended. The latch device design should provide direct visual inspectability to ensure it is fastened and secured.

(D) Any fabric used should be durable and should be at least flame resistant.

(E) Safety harnesses and belts should meet TSO C-22 and TSO-C-114 requirements.

(F) Sharp corners and edges should be avoided and padding should be used, as necessary, to protect the occupants.

NOTE: Acceptable sources of detailed design criteria and standards for PCDS webbing and harness can be found in sources such as U.S. AAVSCOM TR 89-D-22D, "Aircraft Crash Survival Design Guide, Volume IV - Aircraft Seats, Restraints, Litters, and Cockpit/Cabin Delethalization."

(G) Occupant retention devices and related design safety features should be used as necessary. In simple designs, only a lack of sharp corners and edges with adequate strapping (or other means of HEC retention relative to the PCDS) and head supports/pads may be all the safety features that are necessary. However, in more complex PCDS designs, safety features such as seat belts, hand holds, shoulder harnesses, placards, and/or other personnel safety standards may be required.

d(13) (continued)

(H) The PCDS design should use methods of compliance in other relevant paragraphs of this AC or equivalent methods.

(iv) Reliability. The reliability level goal for the PCDS and its attachments to the rotorcraft is extremely improbable (i.e., $1 \times 10^{-9}$ failures per flight) for all failure modes that could cause either catastrophic failure, serious injuries, and/or fatalities anywhere in the total airborne system. All significant failure modes of lesser consequence should be rendered improbable (i.e., $1 \times 10^{-5}$ failures per flight). One acceptable method of achieving this goal is to submit and achieve approval of the following:

(A) A PCDS level FMEA that minimizes any potential catastrophic failures that are not extremely improbable and minimizes any other lesser, significant failures that are not improbable.

(B) A repetitive test of all functional devices that cycles these devices under critical structural conditions, operational conditions, or a combination at least 30 times.

(C) An environmental qualification review over the proposed operating environment.

NOTE: A complete environmental qualification test as described in d(3)(iii)(C) is necessary unless the design features would clearly not necessitate employment of all or part of the test program of d(3)(iii)(C).

(v) EMI and lightning protection. All essential, affected components of the PCDS, such as intercommunication equipment, should be protected against RF field strengths to a minimum of RTCA/DO-160 CAT Y. (Reference d(9)(ii).)

d(13) (continued)

(vi) Continued airworthiness. All instructions and documents necessary for continued airworthiness, normal operations, and emergency operations should be completed, reviewed, and approved during the certification process.

(vii) Flotation devices. PCDS's that are intended to have a dual role as floatation devices or life preservers should meet the requirements of TSO-C13f, "Life Preservers." Also, any PCDS design to be used in the water should have a floatation kit. The kit should support the weight of the maximum number of occupants and the PCDS in the water and minimize the possibility of the occupants floating face down.

(viii) Aerodynamic considerations. Litters and other types of PCDS designs may (because of effects from sources such as down drafts, maneuvers, or gusts) spin, twist or otherwise respond unacceptably in flight. These designs should be structurally restrained with devices such as a spider, a harness, or an equivalent device to minimize undesirable flight dynamics.

(ix) Medical design considerations. The PCDS should be designed to the maximum practicable extent and placarded to maximize the HEC's protection from medical considerations such as blocked air passages induced by improper body configuration and excessive loss of body heat during operations. HEC (especially injured and/or water soaked persons) may be exposed to high body heat loss from sources such as rotor wash and the airstream. PCDS occupant safety from transit induced medical considerations can be greatly increased by proper design.

(x) Special PCDS configurations. Certain PCDS configurations may be submitted for approval that have special design considerations. Known configurations and their special design considerations are described, as follows:

Net type PCDS's. A well-designed net type PCDS has the advantage of being able to quickly evacuate several combinations of able and/or disabled HEC. Net type PCDS's should be designed such that enough rigid or semi-rigid components are present so that the net does not close in and entrap, injure, further injure, and/or create panic from claustrophobia to the HEC occupants during rescue. Secondly, if intended for water use, the net type PCDS should have proper flotation so it does not drag the HEC underwater. Thirdly, the net type PCDS should be easily ingressed so that the HEC will readily climb into the net and not try to hang onto the outside of the net.

(14) Summary of Current PCDS Designs that relate to § 27.865(c)(3): In relation to § 27.865(c)(3), several commercial and military PCDS's exist and are used for emergency rescue work involving HEC. Known devices are summarized in FIGURE AC 27.MG 12-3. Some devices are not approved; however, applications that involve them may be submitted for approval.

(15) Compliance Procedures for QRS Design, Installation, and Placarding under § 27.865(c)(3): For jettisonable HEC applications, the QRS design, installation, and associated placarding should be given special consideration to ensure the proper level of occupant safety.

(16) Compliance Procedures for Intercom Systems for HEC Operations under § 27.865(c)(4): For all HEC operations, the rotorcraft is required to be equipped for or otherwise allow direct intercommunication under any operational conditions among crewmembers and the HEC. It is intended that for simple systems, voice or hand signals to PCDS occupants (if not in conflict with operations requirements) would be acceptable. In more complex systems, it is intended that more sophisticated devices such as intercoms be provided.

(17) Compliance Procedures for Flight Manual Procedures and Limitations for HEC Operations under § 27.865(c)(5): All appropriate flight manual procedures and limitations for all HEC operations are required to be present and to be approved. These instructions and manuals should be proofed during flight tests (Reference d(19)).

(18) Compliance Procedures for Special Conditions Encountered in Operations: If special conditions will be encountered in operations such as low visibility and night use, then provisions such as night lighting that provide the proper level of safety for both the rotorcraft and HEC when operating under these special conditions should be identified, considered, and approved during certification. This determination should be made on a case-by-case basis during either initial or supplemental certification using the proposed operating environment scenario.

(19) Compliance Procedures for Flight Test Verification Work under § 27.865(d): Flight test verification work (or an equivalent combination of analysis and ground testing, either in conjunction with or in addition to operations rules such as Part 133 for the U.S.) that thoroughly examines the operational envelope should be conducted with the external cargo carriage device for which approval is requested (especially those that involve HEC). The flight test program should show that all aspects of the operations applied for are safe, uncomplicated, and can be conducted by a qualified flight crew under the most critical service environment and, in the case of HEC, under emergency pressure. Flight tests should be conducted for the simulated representative NHEC and HEC loads to demonstrate their in-flight handling and separation characteristics.

(i) General. Flight testing (or an equivalent combination of analysis and testing) should be conducted under the critical combinations of configurations and operating conditions for which basic type certification approval is sought. Additional combinations of external load and operating conditions may be subsequently approved under relevant operational requirements as long as the structural limits and reliability considerations of the basic certification approval are not exceeded (i.e., equivalent safety is maintained). The qualification flight test work of this subparagraph is intended to be accomplished primarily by analysis and/or bench testing. However, at least one in-flight, limit load drop test should be conducted for the critical load case. If one critical load case cannot be clearly identified, then more than one drop test might be necessary. Also, in-flight tests for the minimum load case (i.e., typically the cable hook itself) with the load trailing both in the minimum and maximum cable length configurations should be conducted. Any safety-of-flight limitations should be documented and placed in the rotorcraft flight manual. Also, in certain low-gross weight, jettisonable HEC configurations, the PCDS may act as a trailing airfoil (i.e., exhibit lift characteristics above certain airspeeds) that could result in entangling the PCDS and the rotorcraft. These configurations should be assessed on a case-by-case basis by analysis and/or flight test to assure any safety-of-flight limitations are clearly identified and placed in the rotorcraft flight manual.

<u>d(19) (continued)</u>

(ii) <u>Determination of one engine inoperative (OEI) hover performance</u>. If the applicant wishes (for a specialized Part 27 operation) to type certificate to Category A and provide hover capability with one engine inoperative, the applicant should provide flight manual OEI performance information for each operating weight, altitude, and temperature.

(A) In determining OEI hover performance, dynamic engine failures should be considered. Each hover verification test should begin from a stabilized hover at the maximum OEI hover weight, at the requested in-ground effect (IGE) or out-of-ground-effect (OGE) skid/wheel height, and with all engines operating. At this point, the critical engine should be failed and the aircraft should demonstrate the capability to maintain a stabilized hover condition without exceeding any rotor limits or engine limits for the operating engine(s). As with all performance testing, engine power should be limited to minimum specification power. Engine failures may be simulated by rapidly moving the throttle to idle provided a needle split is obtained between the rotor and the engine RPM.

(B) Normal pilot reaction should be used following the engine failure to maintain the stabilized hover flight condition. When hovering OGE or IGE at maximum OEI hover weight, an engine failure should not result in an altitude loss of more than 10 percent or 4 feet, whichever is greater, of the altitude established at the time of engine failure. In either case, sufficient power margin should be available from the operating engine(s) to regain the altitude lost during the dynamic engine failure and to transition to forward flight.

(C) The time required to recover an external load (especially HEC loads) and to transition to forward flight should also be considered. This time increment may limit the use of short duration, OEI power ratings. For example, for a helicopter that sustains an engine failure at a height of 40 feet, the time required to restabilize in a hover, recover the external load (given hoist speed limitations), and then transition to forward flight (with minimal altitude loss) would likely preclude the use of a 30-second engine ratings and may encroach upon 2 1/2-minute ratings.

(D) In addition, for those helicopters that incorporate engine driven generators, the hoist should remain operational following an engine/generator failure. A hoist should not be powered from a bus that is automatically shed following the loss of an engine/generator. Maximum two engine generator loads should be established such that when one engine/generator fails, the remaining generator can assume the entire rotorcraft electrical load (including maximum hoist electrical load) without exceeding approved limitations.

(E) The Rotorcraft Flight Manual (RFM) should contain information that describes the expected altitude loss, any special recovery techniques, and the time

d(19) (continued)

increment needed for recovery of the external load when establishing maximum weights and skid heights. The OEI hover chart may be placed in the performance section of the RFM or RFM supplement. Allowable altitude extrapolation for the hover data should not exceed 2,000 feet.

(iii) Separation characteristics of jettisonable external loads. For any RLC for any applicable cargo type, satisfactory post-jettison separation characteristics of all loads should meet the minimum criteria that follow:

(A) Immediate "clean" operation of the QRS, including "clean" separate functioning of the PQRS and BQRS.

(B) No damage to the helicopter during or following actuation of the QRS and load jettisoning.

(C) A jettison trajectory clear of the helicopter.

(D) No inherent instability of the jettisonable (or just jettisoned) HEC and/or NHEC while in proximity to the helicopter.

(E) No adverse or uncontrollable helicopter reactions at the time of jettison.

(F) Stability and control characteristics after jettison should be within the originally certified limits.

FIGURE AC 27.MG 12-3

| DEVICE | FAA APPROVED[2] | SOURCE |
|---|---|---|
| Stokes litter (one person) | No | U.S. Coast Guard |
| Rescue Basket | No | U.S. Coast Guard |
| Rescue Sling (one person)[1] | Yes | U.S. Coast Guard |
| Rescue Net (STC7586SW)[2] | Yes | Billy Pugh Co., Inc.<br>P.O. Box 802<br>1415 N. Water Street<br>Corpus Christi, TX 78403 |
| LII (STC7731SW)[2] | Yes | Life Industries International, Inc.<br>4170 Rogers Avenue<br>Suite D, Box 3284<br>Fort Smith, AR |

NOTES:

1. The "rescue sling" or "rescue strop" is a "horse collar" device that requires a person to exert some effort to remain in the collar. Some versions of the rescue sling have retainer straps to help secure an occupant in the horse collar. These straps are typically located in pockets on each side of the collar and are usually marked "pull." The straps go around the occupant's back and clip together with a "V" ring and a quick ejector fitting. This device should only be used on a fully conscious individual, unless the individual is fully retained by devices such as retention straps. Even an alert, well-trained individual may have nerves impinged on by pressure from this device. Nerve impingement may result in loss of sensation in the arms, loss of grip, and inadvertent fall from the harness. The retainer strap version of the rescue sling should only be used in conjunction with properly written instructions and placards and with trained personnel.

2. FAA approval is for a specific installation only; each new installation is required to still be approved.

3. Other types of emergency rescue devices that are not listed but have been successfully used by the military are the Screamer Suit and the Jungle Penetrator. The screamer suit or harness (full body fishnet) is a PCDS constructed of mesh and webbing. It was originally designed to physically encompass the torso of HEC rescue subjects who are disabled or unconscious to prevent them from inadvertently falling out of the PCDS. It is a relatively simple device for a rescuer to use. The Jungle Penetrator is a heavy device (typically metal) with a tapered end. It will break light timber and brush when dropped in free-fall from the rotorcraft to an evacuee. It typically has arms that swing down on which HEC can ride and a webbing loop to hold the HEC onto the device.

d(19) (continued)

(G) No unacceptable degradation of the helicopter performance characteristics after jettison.

(iv) Jettison requirements for jettisonable external loads. For representative cargo types (low, medium, and high density loads on long and short lines), emergency and normal jettison procedures should be demonstrated (by a combination of analysis, ground tests, and flight tests) at sufficient combinations of flight conditions to establish a jettison envelope which should be placed in the flight manual.

(v) QRS demonstration. Repetitive jettison demonstrations should be conducted that use the PQRS. Except, the BQRS should be utilized at least once.

(vi) QRS reliability (i.e., failure modes) affecting flight performance. The FMEA of the QRS (reference d(7) and d(8)) should show that any single system failure will not result in unsatisfactory flight characteristics. For any QRS failures resulting in asymmetric loading conditions, the helicopter should be shown to be safely flyable. Performance characteristics should not be adversely affected by any QRS failure mode.

(vii) Flight test weight and CG locations. All flight tests should be conducted at the extreme or critical combinations of weight and longitudinal and lateral CG conditions within the applied for flight envelope. The rotorcraft should remain within approved weight and CG limits both with the external load applied and after jettison of the load.

(viii) Flight Speed Envelopes. Emergency and normal jettison demonstrations should be performed at sufficient airspeeds to establish any airspeed restrictions for satisfactory separation characteristics. The maximum and minimum airspeed limits for safe separation should be determined. The sideslip envelope as a function of airspeed should be determined.

(ix) Altitude. Emergency and normal jettison demonstrations should be performed at altitudes consistent with the approvable operational envelope and with the maneuvering requirements necessary to overcome any adverse effects of the jettison.

(x) Attitude. Emergency and normal jettison demonstrations should be performed from all attitudes appropriate to normal and emergency operational usage. Where the attitudes of HEC and/or NHEC with respect to the helicopter may be varied, the most critical attitude should be demonstrated. This demonstration would normally be accomplished by bench testing.

d(19) (continued)

(xi) Winch/hoist/rescue hook systems and/or cargo hook systems. These articles should be flight demonstrated per d(3)(x).

(20) Compliance Procedures for External Loads Placards and Markings under § 27.865(e): Placards and markings should be installed next to the external load attaching means, in a clearly noticeable location, that state the primary operational limitations - specifically including the maximum authorized external load. Not all operational limitations need be stated on the placard (or equivalent markings) only those clearly necessary for immediate reference in operations. Other more detailed and/or operational limitations of lesser immediate reference need should be stated either directly in the RFM or in a supplement thereto (See also, d(2)(vi)).

(21) Compliance Procedures for Fatigue Substantiation under § 27.865(f): The fatigue evaluation of § 27.571 should be applied as follows:

NOTE: The term "hazard to the rotorcraft" is defined to include all hazards to either the rotorcraft, to the occupants thereof, or both.

(i) Fatigue evaluation of NHEC applications. Any critical components of the suspended system and their attachments (such as the cargo hook or bolted or pinned truss attachments), the failure of which could result in a hazard to the rotorcraft, should include an acceptable fatigue analysis in accordance with AC 20-95, Section 9.

(ii) Fatigue evaluation of HEC applications. The entire PCDS and its attachments should be reviewed on a component-by-component basis to determine which, if any, components are fatigue critical or damage intolerant. These components should be analyzed and/or tested (per AC 20-95 or other equivalent methods) to ensure their fatigue life limits are properly determined and placed in the limited life section of the maintenance manual.

(22) Compliance Procedures for Agricultural Installations (AI's): AI's can be certified for either jettisonable or non-jettisonable NHEC or HEC operations as long as they meet relevant certification and operations requirements and follow appropriate compliance methods. However, most current AI designs are external fixtures (see definition) - not external loads. External fixtures are not certifiable as jettisonable external cargo because they do not have a true payload (see definition), true jettison capability (see definition), or a complete QRS. Many AI designs can dump their solid or liquid chemical loads by use of a "purge port" release over a relatively long time period (i.e., greater than 30 seconds). This is not considered true jettison capability (see definition) since the external load is not released by a QRS and since the release time

d(22) (continued)

span is typically greater than 30 seconds (reference c(20) and d(7)). Thus, these types of AI's should be certified as a non-jettisonable external load. However, other designs that have the entire AI (or significant portions thereof) attached to the rotorcraft, that have short time frame jettison (or release) capability provided by a QRS that meets the definitions herein and that have no post-jettison characteristics that would endanger continued safe flight and landing may be certified as a jettisonable external load. For example, if all the relevant criteria are properly met, a jettisonable fluid load can be certified as a NHEC external cargo. AC 27 MG 5 discusses other AI certification methodology.

(23) Compliance Procedures for External Tank Configurations: External tank configurations that have true payload (see definition) and true jettison capability (see definition) should be certified as jettisonable NHEC. External tank configurations that have a true payload capability but do not have true jettison capability should be certified as non-jettisonable NHEC. An external tank that has neither a true payload capability nor true jettison capability is an external fixture; it should not be certified under § 27.865 (i.e., as an external load). If an external tank is to be jettisoned in flight, it should have a QRS that is approved for the maximum jettisonable external tank payload and is either inoperable or is otherwise rendered reliable to minimize inadvertent jettisons above the maximum jettisonable external tank payload.

(24) Compliance Procedures for Logging operations: These operations are very susceptible to low-cycle fatigue because of the large loads and relatively high load cycles that are common to this industry. It is recommended that load measuring devices (such as load cells) be used to ensure that no unrecorded overloads occur and to ensure that cycles producing high fatigue damage are properly considered. Cycle counters are recommended to ensure acceptable cumulative fatigue damage levels are identifiable and are not exceeded. As either a supplementary method or alternate method, maintenance instructions should be considered to ensure proper cycle counting and load recording during operations.

(25) Compliance Procedures for Noise Certification: FAR 36 is the noise certification standard. Section 36.1(a)(4) specifically exempts helicopters that are designed exclusively for agricultural work, carrying firefighting materials, or external loads activity from the noise standards. FAR 21.93(b)(4) also contains specific information regarding external loads and what configurations constitute/do not constitute an acoustical change.

(26) Compliance Procedures for Inspection and Maintenance Considerations. Maintenance manuals (and supplements thereto) developed by applicants for external load applications should be presented for approval and should include all appropriate

d(26) (continued)

inspection and maintenance procedures. The applicant should provide sufficient data and other information to establish the frequency, extent, and methods of inspection of critical structure, systems and components thereof. This information must be included in the maintenance manual as required by § 27.1529. For example, maintenance requirements for sensitive QRS squibs should be carefully determined, documented, approved during certification, and included as specific mandatory scheduled maintenance requirements that may require either "daily" or "pre-flight" checks (especially for HEC applications).

FIGURE AC 27.MG 12-4: SUMMARY OF RELEVANT INFORMATION FOR U.S. PART 133 ROTORCRAFT LOAD COMBINATIONS CERTIFIABLE UNDER § 27.865

| Basic Definition and Intended Use Class A | Typical Load Limits | Quick Release Requirements | Certification Requirements and Considerations |
|---|---|---|---|
| <u>Fixed External Cargo Container</u> - Is defined by § 1.1 as a load combination in which the external load cannot move freely, cannot be jettisoned, and does not extend below the landing gear. This category usually features multiple attachments (loadpaths) to the airframe. A typical example is a hard mounted cargo basket attached to the rotorcraft crosstubes which is used to carry external cargo from point A to point B. A non-typical example is a removable advertising sign that is in a folded configuration during take-off and landing, but is extended during flight. Maximum rotorcraft gross weight with external load may not exceed the maximum internal load gross weight approved under § 27.25(a). | Certification limit load is $N_{ZW}$ X Maximum Substantiatable External Load. $N_{ZW}$ is 2.5 per § 27.865 (See Procedure, paragraph d(2)(ii)) for NHEC cargo. For HEC, $2.5 \le N_{ZW} \le 3.5$ depending on gross weight (see Procedure paragraph d(2)(iii)). | None. Cargo and its container are not jettisonable. | • For HEC and NHEC external cargo. (See FIGURE AC 27.MG 12-1)<br>• Flight Manual Restrictions - § 133.47 requires a rotorcraft load combination flight manual supplement. Any flight envelope restrictions and emergency procedures from § 27.865 should be a part of this supplement.<br>• The rotorcraft does not need Category A and OEI hover capability to carry HEC.<br>• Load limit placards are required by § 27.865(c).<br>• Flight envelope restriction placards may also be required for gross weight limitations, elimination of dangerous maneuvers, HEC requirements, etc.<br>• Cargo tiedowns to prevent load shifting relative to airframe and for inflight load retention may be required.<br>• Effect of external cargo carrier and its maximum cargo weight on load paths, loads and fatigue of existing structure should be determined.<br>• Type Inspection Authorization (TIA) testing may be necessary to determine whether or not the system performs as intended and if placards and flight manual supplements are adequate.<br>• The applicant should test the aerodynamic effect of several representative load shapes and include applicable information in the flight manual supplement. If such information is not in the RFM, then the operator may be required to obtain an operations approval under Part 133.<br>• PCDS (i.e., the entire attached HEC carrying device) should be reviewed for relevant occupant safety criteria and placarding.<br>• If all relevant criteria are met, non-jettisonable external tank loads (i.e., fluid or other loads) can be certified as a Class A RLC [Reference d(22) and d(23)].<br>• To be certified under § 27.865 as a Class A RLC, the external load and its carrying device should have true payload capability (see definition) (i.e., it should be an external load, not an external fixture). |

FIGURE AC 27.MG 12-4: SUMMARY OF RELEVANT INFORMATION FOR U.S. PART 133 ROTORCRAFT LOAD COMBINATIONS CERTIFIABLE UNDER § 27.865 (continued)

| Basic Definition and Intended Use Class B | Typical Load Limits | Quick Release Requirements | Certification Requirements and Considerations |
|---|---|---|---|
| <u>Single or Multiple Point Suspension External Load Airborne</u><br>Is defined by § 1.1 as a load combination in which the external load is jettisonable and is lifted free of land or water during the rotorcraft operation. The payload is typically suspended from a hook or a similar device. The hook may be attached to the rotorcraft structure, or it may be attached to a movable hoist cable with the hoist itself attached to the rotorcraft. A typical use is to lift a cargo load until it is completely airborne and fly it from point A to point B. The external hoist load may be stowed in the fuselage (in some cases) while being transported. The rotorcraft maximum gross weight with external load attached may exceed the maximum internal gross weight approved under § 27.25(a) as long as all weight above the maximum internal weight is jettisonable. | Certification limit load is $N_{ZW}$ X Maximum Substantiatable External load. $N_{ZW}$ is 2.5 per § 27.865 (See Procedure, paragraph d(2)(ii) for NHEC). Load may be limited by winch/hoist allowables. For HEC, $2.5 \leq N_{ZW} \leq 3.5$ depending on gross weight (see Procedure paragraph d(2)(iii)). | Yes - § 27.865(b)(1) requires that a primary quick release subsystem control device be installed on a primary control or in an equivalently accessible location. Also, a backup quick release system actuation device should be available and readily accessible. | • For HEC or NHEC external cargo (See FIGURE AC 27.MG 12--1).<br>• Flight Manual Restrictions - § 133.47 requires a rotorcraft load combination flight manual supplement. Any flight envelope restrictions and emergency procedures from § 27.865 should be a part of this supplement.<br>• The rotorcraft does not need Category A and OEI hover capability to carry HEC.<br>• Load limit placards are required by § 27.865(c).<br>• Flight envelope restriction placards may also be required for HEC.<br>• Certifiable external cargo load capacity may be further limited by §§ 133.41 and 133.43.<br>• Quick release subsystems and devices should be approved and be operable on a nonhazard basis by the pilot per § 27.865(b).<br>• Quick release backup subsystems should be reliable but need not be overly sophisticated (cable cutters, axes, etc., used by crewmembers).<br>• Effect of maximum suspended load and its attachment to rotorcraft structure on load paths, loads and fatigue of existing structure should be determined.<br>• TIA testing may be necessary to determine whether or not the system performs as intended and if placards and flight manual supplements are adequate.<br>• PCDS (i.e., the entire attached human external cargo carrying device) should be reviewed for relevant occupant safety criteria and placarding.<br>• If all relevant criteria are met, jettisonable loads (i.e., fluid or other loads) can be certified as a Class B RLC [reference d(22) and d(23)]. |

FIGURE AC 27.MG 12-4: SUMMARY OF RELEVANT INFORMATION FOR U.S. PART 133 ROTORCRAFT LOAD COMBINATIONS CERTIFIABLE UNDER § 27.865 (continued)

| Basic Definition and Intended Use Class C | Typical Load Limits | Quick Release Requirements | Certification Requirements and Considerations |
|---|---|---|---|
| <u>Single or Multiple Point Suspension External Load Partially Airborne</u> - Is defined by § 1.1 as an RLC in which the external load is jettisonable and remains in contact with land or water during the rotorcraft operation. The payload is typically partially suspended by a net or cables from a cargo hook or a similar device. The cargo hook may be attached to the rotorcraft structure or may be attached to a movable hoist cable and the hoist itself attached to the rotorcraft. A typical use is for stringing wire or laying cable where the payload is only partially suspended from the ground. (Note: Many applications combine both Category B and C operations because of the obvious utility involved.) The rotorcraft maximum gross weight with external load attached may exceed the maximum internal gross weight approved under § 27.25(a) as long as all weight above the maximum internal weight is jettisonable. | Certification limit load is $N_{ZW}$ X Maximum Substantiatable External load. $N_{ZW}$ is 2.5 per § 27.865 (See Procedure, paragraph d(2)(ii) for NHEC). Load may be limited by hoist allowables. For HEC, $2.5 \leq N_{ZW} \leq 3.5$ depending on gross weight (see Procedure paragraph d(2)(iii)). | Yes - § 27.865(b)(1) requires that a primary quick release subsystem control device be installed on a primary control or in an equivalently accessible location. Also, a backup quick release subsystem control device should be available and readily accessible. | • For HEC or NHEC external cargo (See FIGURE AC 27.MG 12-1).<br>• Flight Manual Restrictions - § 133.47 requires a rotorcraft load combination flight manual supplement. Any flight envelope restrictions and emergency procedures from § 27.865 should be a part of this supplement.<br>• The rotorcraft does not need Category A and OEI hover capability to carry HEC.<br>• Load limit placards are required by § 27.865(c).<br>• Flight envelope restriction placards may also be required for HEC.<br>• Certifiable external cargo load capacity may be further limited by §§ 133.41 and 133.43.<br>• Quick release subsystems and devices should be approved and be operable on a nonhazard basis by the pilot per § 27.865(b).<br>• Quick release backup subsystems should be reliable, but need not be overly sophisticated (cable cutters, axes, etc., used by a crewmember).<br>• Effect of the maximum suspended/attached load and its attachment to rotorcraft structure on load paths, loads and fatigue of existing structure should be determined.<br>• TIA testing may be necessary to determine whether or not the system performs as intended and if placards and flight manual supplements are adequate.<br>• PCDS (i.e., the entire attached HEC carrying device) should be reviewed for relevant occupant safety criteria and placarding. |